```
#downloading data
!git clone https://github.com/rslim087a/track
```

```
Cloning into 'track'...
remote: Enumerating objects: 12163, done.
remote: Total 12163 (delta 0), reused 0 (delta 0), pack-reused 12163
Receiving objects: 100% (12163/12163), 156.98 MiB | 17.89 MiB/s, done.
Updating files: 100% (12160/12160), done.
```

```
import os
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
from tensorflow import keras
import tensorflow as tf
from keras.models import Sequential
from keras.layers import Convolution2D, MaxPooling2D, Dropout, Flatten, Dense, Conv2D
from sklearn.utils import shuffle
from sklearn.model_selection import train_test_split
from imgaug import augmenters as iaa
import cv2
import pandas as pd
import ntpath
import random
```

```
datadir = 'track'
columns = ['center', 'left', 'right', 'steering', 'throttle', 'reverse', 'speed']
data = pd.read_csv(os.path.join(datadir, 'driving_log.csv'), names = columns)
pd.set_option('display.max_colwidth', -1)
data.head()
```

```
<ipython-input-3-8dde8c7f6a42>:4: FutureWarning: Passing a negative integer is dep
  pd.set_option('display.max_colwidth', -1)
```

	center	
0	C:\Users\Amer\Desktop\new_track\IMG\center_2018_07_16_17_11_43_382.jpg	C:\Users\Amer
1	C:\Users\Amer\Desktop\new_track\IMG\center_2018_07_16_17_11_43_670.jpg	C:\Users\Amer
2	C:\Users\Amer\Desktop\new_track\IMG\center_2018_07_16_17_11_43_724.jpg	C:\Users\Amer
3	C:\Users\Amer\Desktop\new_track\IMG\center_2018_07_16_17_11_43_792.jpg	C:\Users\Amer
4	C:\Users\Amer\Desktop\new_track\IMG\center_2018_07_16_17_11_43_860.jpg	C:\Users\Amer

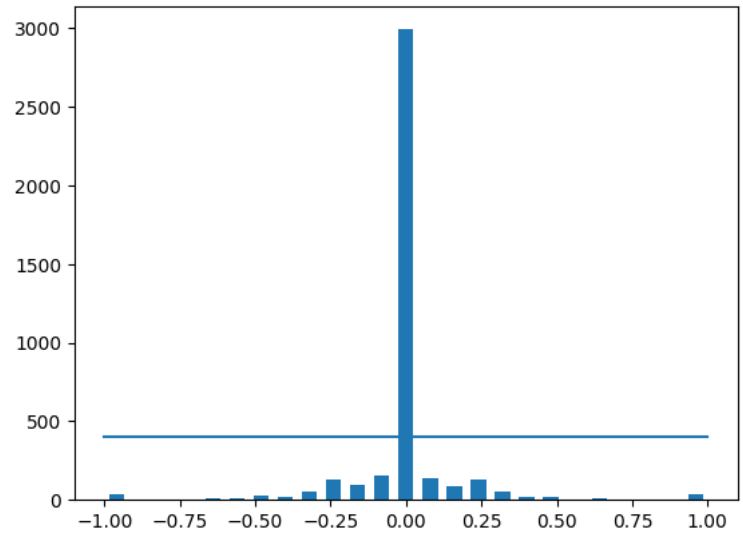
```
def path_leaf(path):
  head, tail = ntpath.split(path)
  return tail
data['center'] = data['center'].apply(path_leaf)
data['left'] = data['left'].apply(path_leaf)
data['right'] = data['right'].apply(path_leaf)
data.head()
```

	center	left	
0	center_2018_07_16_17_11_43_382.jpg	left_2018_07_16_17_11_43_382.jpg	right_2018_07_
1	center_2018_07_16_17_11_43_670.jpg	left_2018_07_16_17_11_43_670.jpg	right_2018_07_
2	center_2018_07_16_17_11_43_724.jpg	left_2018_07_16_17_11_43_724.jpg	right_2018_07_
3	center_2018_07_16_17_11_43_792.jpg	left_2018_07_16_17_11_43_792.jpg	right_2018_07_
4	center_2018_07_16_17_11_43_860.jpg	left_2018_07_16_17_11_43_860.jpg	right_2018_07_

```
num_bins = 25
samples_per_bin = 400
hist, bins = np.histogram(data['steering'], num_bins)
center = (bins[:-1]+ bins[1:]) * 0.5
```

```
plt.bar(center, hist, width=0.05)
plt.plot((np.min(data['steering']), np.max(data['steering'])), (samples_per_bin, samples_per_bin))
```

```
[<matplotlib.lines.Line2D at 0x7baf99317a90>]
```




```
print('total data:', len(data))
print(data.shape)
```

```
total data: 4053
(4053, 7)
```

```
remove_list = []
for j in range(num_bins):
  list_ = []
  for i in range(len(data['steering'])):
    if data['steering'][i] >= bins[j] and data['steering'][i] <= bins[j+1]:
      list_.append(i)
  list_ = shuffle(list_)
  list_ = list_[samples_per_bin:]
  remove_list.extend(list_)

print('removed:', len(remove_list))
data.drop(data.index[remove_list], inplace=True)
print('remaining:', len(data))
```

```
removed: 2590
remaining: 1463
```

```
hist, _ = np.histogram(data['steering'], (num_bins))
plt.bar(center, hist, width=0.05)
plt.plot((np.min(data['steering']), np.max(data['steering'])), (samples_per_bin, samples_per_bin))
```

```
def load_img_steering(datadir, df):
  image_path = []
  steering = []
  for i in range(len(data)):
    indexed_data = data.iloc[i]
    center, left, right = indexed_data[0], indexed_data[1], indexed_data[2]
    image_path.append(os.path.join(datadir, center.strip()))
    steering.append(float(indexed_data[3]))
    # left image append
    image_path.append(os.path.join(datadir,left.strip()))
    steering.append(float(indexed_data[3])+0.15)
    # right image append
    image_path.append(os.path.join(datadir,right.strip()))
    steering.append(float(indexed_data[3])-0.15)
  image_paths = np.asarray(image_path)
  steerings = np.asarray(steering)
  return image_paths, steerings
```

```
         −1.00  −0.75  −0.50  −0.25   0.00   0.25   0.50   0.75   1.00
```

```
image_paths, steerings = load_img_steering(datadir + '/IMG', data)
```

```
len(image_paths)
```

```
4389
```

```
len(steerings)
```

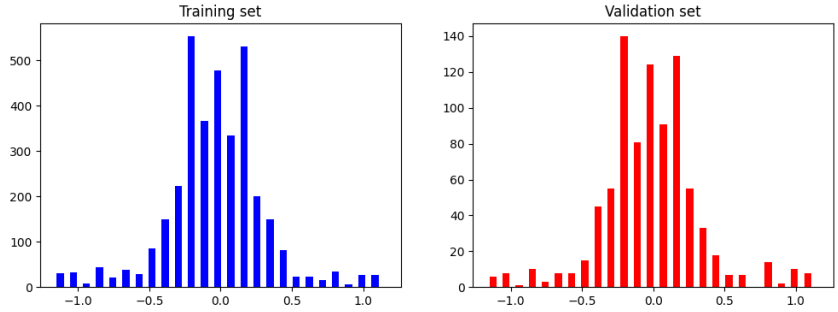
```
4389
```

```
X_train, X_valid, y_train, y_valid = train_test_split(image_paths, steerings, test_size=0.2, random_state=6)
print('Training Samples: {}\nValid Samples: {}'.format(len(X_train), len(X_valid)))
```

```
Training Samples: 3511
Valid Samples: 878
```

```
fig, axes = plt.subplots(1, 2, figsize=(12, 4))
axes[0].hist(y_train, bins=num_bins, width=0.05, color='blue')
axes[0].set_title('Training set')
axes[1].hist(y_valid, bins=num_bins, width=0.05, color='red')
axes[1].set_title('Validation set')
```

```
Text(0.5, 1.0, 'Validation set')
```

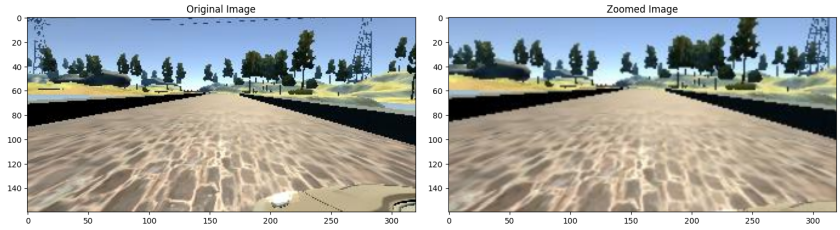



```
def zoom(image):
  zoom = iaa.Affine(scale=(1, 1.3))
  image = zoom.augment_image(image)
  return image
```

```
image = image_paths[random.randint(0, 1000)]
original_image = mpimg.imread(image)
zoomed_image = zoom(original_image)

fig, axs = plt.subplots(1, 2, figsize=(15, 10))
fig.tight_layout()

axs[0].imshow(original_image)
axs[0].set_title('Original Image')
```

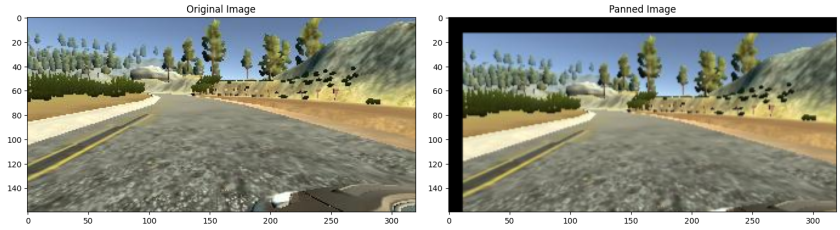
```
axs[1].imshow(zoomed_image)
axs[1].set_title('Zoomed Image')
```

```
Text(0.5, 1.0, 'Zoomed Image')
```




```
def pan(image):
  pan = iaa.Affine(translate_percent= {"x" : (-0.1, 0.1), "y": (-0.1, 0.1)})
  image = pan.augment_image(image)
  return image

image = image_paths[random.randint(0, 1000)]
original_image = mpimg.imread(image)
panned_image = pan(original_image)

fig, axs = plt.subplots(1, 2, figsize=(15, 10))
fig.tight_layout()

axs[0].imshow(original_image)
axs[0].set_title('Original Image')

axs[1].imshow(panned_image)
axs[1].set_title('Panned Image')
```

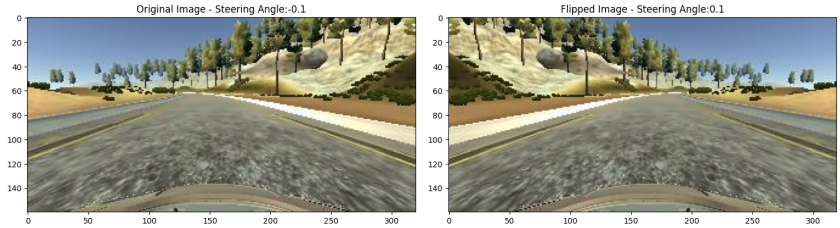
```
Text(0.5, 1.0, 'Panned Image')
```



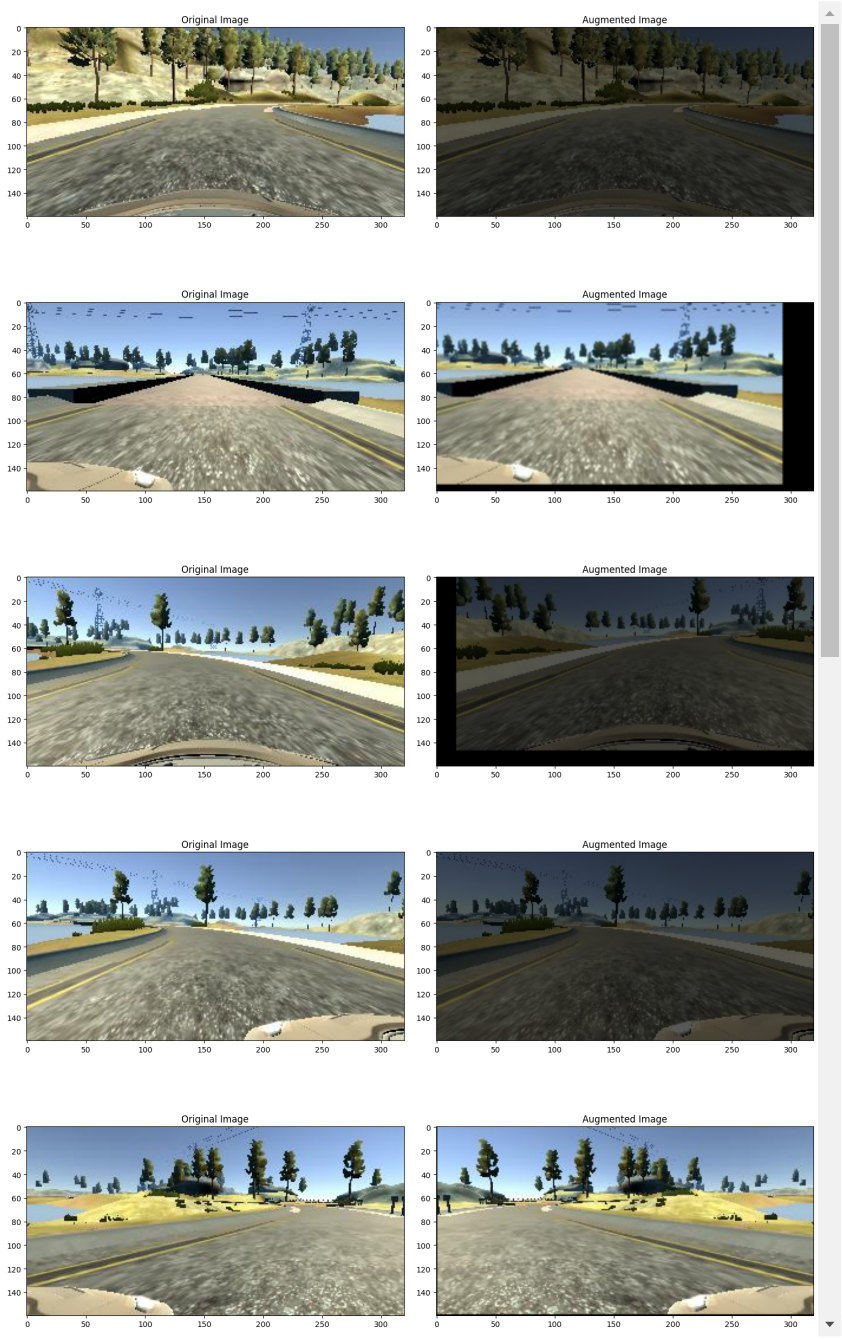

```
def img_random_brightness(image):
    brightness = iaa.Multiply((0.2, 1.2))
    image = brightness.augment_image(image)
    return image

image = image_paths[random.randint(0, 1000)]
original_image = mpimg.imread(image)
brightness_altered_image = img_random_brightness(original_image)


fig, axs = plt.subplots(1, 2, figsize=(15, 10))
fig.tight_layout()

axs[0].imshow(original_image)
axs[0].set_title('Original Image')

axs[1].imshow(brightness_altered_image)
axs[1].set_title('Brightness altered image ')
```

```
def img_random_flip(image, steering_angle):
    image = cv2.flip(image,1)
    steering_angle = -steering_angle
    return image, steering_angle

random_index = random.randint(0, 1000)
image = image_paths[random_index]
steering_angle = steerings[random_index]

original_image = mpimg.imread(image)
flipped_image, flipped_steering_angle = img_random_flip(original_image, steering_angle)

fig, axs = plt.subplots(1, 2, figsize=(15, 10))
fig.tight_layout()

axs[0].imshow(original_image)
axs[0].set_title('Original Image - ' + 'Steering Angle:' + str(steering_angle))

axs[1].imshow(flipped_image)
axs[1].set_title('Flipped Image - ' + 'Steering Angle:' + str(flipped_steering_angle))
```

```
Text(0.5, 1.0, 'Flipped Image - Steering Angle:0.1')
```




```
def random_augment(image, steering_angle):
    image = mpimg.imread(image)
    if np.random.rand() < 0.5:
      image = pan(image)
    if np.random.rand() < 0.5:
      image = zoom(image)
    if np.random.rand() < 0.5:
      image = img_random_brightness(image)
    if np.random.rand() < 0.5:
      image, steering_angle = img_random_flip(image, steering_angle)

    return image, steering_angle


ncol = 2
nrow = 10

fig, axs = plt.subplots(nrow, ncol, figsize=(15, 50))
fig.tight_layout()

for i in range(10):
  randnum = random.randint(0, len(image_paths) - 1)
  random_image = image_paths[randnum]
  random_steering = steerings[randnum]

  original_image = mpimg.imread(random_image)
  augmented_image, steering = random_augment(random_image, random_steering)

  axs[i][0].imshow(original_image)
  axs[i][0].set_title("Original Image")

  axs[i][1].imshow(augmented_image)
  axs[i][1].set_title("Augmented Image")
```


Original Image
Augmented Image
Original Image
Augmented Image
Original Image
Augmented Image
Original Image
Augmented Image
Original Image
Augmented Image

```
def img_preprocess(img):
    img = img[60:135,:,:]
    img = cv2.cvtColor(img, cv2.COLOR_RGB2YUV)
    img = cv2.GaussianBlur(img,  (3, 3), 0)
    img = cv2.resize(img, (200, 66))
    img = img/255
    return img



image = image_paths[100]
original_image = mpimg.imread(image)
preprocessed_image = img_preprocess(original_image)

fig, axs = plt.subplots(1, 2, figsize=(15, 10))
fig.tight_layout()
axs[0].imshow(original_image)
axs[0].set_title('Original Image')
axs[1].imshow(preprocessed_image)
axs[1].set_title('Preprocessed Image')


!nvidia-smi


def batch_generator(image_paths, steering_ang, batch_size, istraining):

  while True:
    batch_img = []
    batch_steering = []

    for i in range(batch_size):
      random_index = random.randint(0, len(image_paths) - 1)

      if istraining:
        im, steering = random_augment(image_paths[random_index], steering_ang[random_index])

      else:
```